CLAIMS

What is claimed is:

1. A method for enhancing an image, which comprises:

obtaining a first image signal including pixel values;

obtaining a high-pass image signal having high-frequency components of the first image signal;

obtaining a positive non-zero weighting factor to control a degree of enhancement;

selecting edge pixel values representing a boundary of an edge in the first image;

for suppressing shoots, defining a gain suppressing function having attenuation coefficients to be multiplied with particular pixel values of the high-pass image signal corresponding in location to the edge pixel values;

multiplying the high-pass image signal by the weighting factor and by the gain suppressing function to obtain a result; and

adding the result to the first image signal to obtain an enhanced image signal in which the shoots have been suppressed.

2. The method according to claim 1, which comprises performing the selecting step by evaluating two independent boundary-indicating functions and concluding that a given one of the pixel values of the first image represents the boundary of the edge only if both of the two functions indicate that the given one of the pixel values is on the boundary.

3. The method according to claim 1, wherein:

each of the pixel values of the first image signal is represented by f(m, n), where m represents a vertical position and n represents a horizontal position;

a combination of the step of selecting the edge pixel values and the step of defining the gain suppressing function includes calculating:

$$f_L(m,n) = | f(m,n) - f(m,n-1) |;$$

$$f_R(m,n) = | f(m,n) - f(m,n+1) |;$$

$$d(m,n) = \min(f_L(m,n), f_R(m,n))\text{; and}$$

$$x(m,n)=\begin{cases}\left(\dfrac{d(m,n)}{D}\right)^{J}, & if \quad d(m,n)\le D\\ 1, & otherwise\end{cases};$$

wherein D and J are predetermined non-negative constants;

a combination of the step of selecting the edge pixel values and the step of defining the gain suppressing function includes calculating:

$$\Delta(\mathrm{m,\ n}) = f(m,n+1) - 2\cdot f(m,n) + f(m,n-1);\ \text{and}$$

$$y(m,n)=\begin{cases}\left(\dfrac{|\Delta(m,n)|}{H}\right)^{K}, & if \quad |\Delta(m,n)|\le H\\ 1, & otherwise\end{cases};$$

wherein K is a predetermined non-zero constant; and

the gain suppressing function is represented by β(m, n) and has properties defined by:

$\beta \to 1$ as $x \to 0$ and $y \to 0$;

$\beta \to 0$ as $x \to 0$ and $y \to 1$;

$\beta \to 1$ as $x \to 1$ and $y \to 0$; and

$\beta \to 1$ as $x \to 1$ and $y \to 1$.

4. The method according to claim 3, wherein the gain suppressing function is:

$$\beta(m,n) = \beta(x(m,n), y(m,n)) = 1 - (1 - x(m,n))^p \cdot (y(m,n))^q \text{; and}$$

p and q are predetermined constants.

5. The method according to claim 3, wherein the gain suppressing function is:

$$\beta(m,n) = \beta(x(m,n), y(m,n)) = 1 - (1 - x(m,n))^p \cdot (y(m,n))^q \text{; and}$$

p and q are predetermined constants.

6. The method according to claim 1, wherein the edge extends in a horizontal direction.

7. The method according to claim 1, wherein the edge extends in a vertical direction.

8. The method according to claim 1, wherein the step of obtaining the high-pass image signal includes filtering the first image signal.

9. The method according to claim 1, wherein the gain suppressing function inherently performs the step of selecting the edge pixel values.

10. The method according to claim 1, wherein:

each of the pixel values of the first image signal is represented by f(m,n), where m represents a vertical position and n represents a horizontal position;

a combination of the step of selecting the edge pixel values and the step of defining the gain suppressing function includes calculating:

$f_L(m,n) = | f(m,n) - f(m-1,n) |$;

$f_U(m,n) = | f(m,n) - f(m+1,n) |$;

$d(m,n) = min(f_L(m,n), f_U(m,n))$; and

$$x(m,n) = \begin{cases} \left(\dfrac{d(m,n)}{D} \right)^J, & if \quad d(m,n) \le D \\ 1, & otherwise \end{cases};$$

wherein D and J are predetermined non-negative constants;

a combination of the step of selecting the edge pixel values and the step of defining the gain suppressing function includes calculating:

$$\Delta(\mathrm{m}, \mathrm{n}) = f(m+1,n) - 2 \cdot f(m,n) + f(m-1,n); \text{ and}$$

$$y(m,n) = \begin{cases} \left(\dfrac{|\Delta(m,n)|}{H} \right)^{K}, & if \quad |\Delta(m,n)| \leq H \\ 1, & otherwise \end{cases} ;$$

wherein K is a predetermined non-zero constant; and

the gain suppressing function is represented by β(m, n) and has properties defined by:

$\beta \to 1$ as $x \to 0$ and $y \to 0$;

$\beta \to 0$ as $x \to 0$ and $y \to 1$;

$\beta \to 1$ as $x \to 1$ and $y \to 0$; and

$\beta \to 1$ as $x \to 1$ and $y \to 1$.

11. The method according to claim 10, wherein the gain suppressing function is:

$$\beta(m,n) = \beta(x(m,n), y(m,n)) = 1 - (1 - x(m,n))^{p} \cdot (y(m,n))^{q}; \text{ and}$$

p and q are predetermined constants.

12. The method according to claim 10, wherein the gain suppressing function is:

$\beta(m,n) = \beta(x(m,n), y(m,n)) = 1 - (1 - x(m,n))^{p} \cdot (y(m,n))^{q}$; and

p and q are predetermined constants.